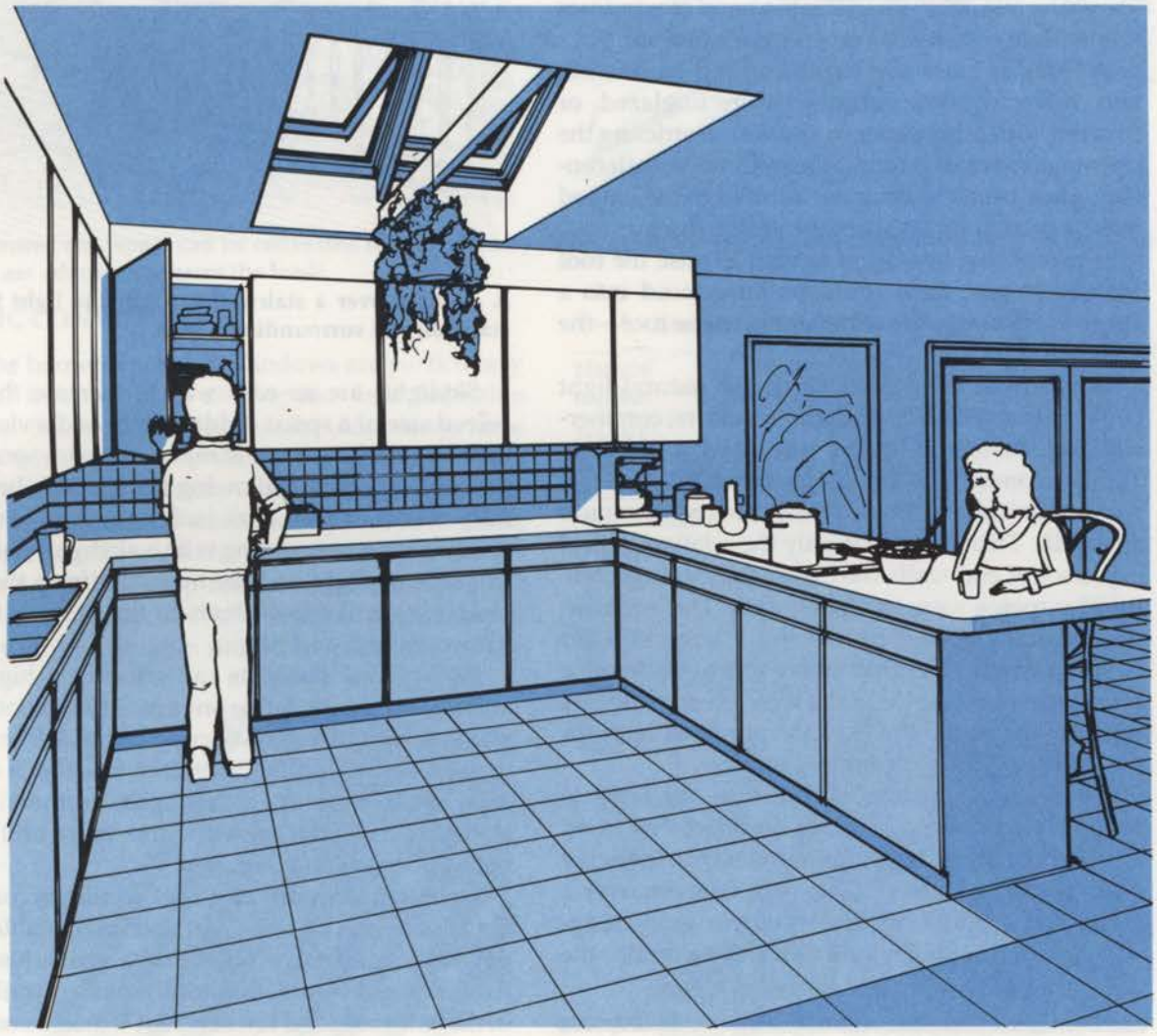
University of Illinois at Urbana-Champaign
Small Homes Council-Building Research Council

COUNCIL NOTES



F11.4 ROOF WINDOWS AND SKYLIGHTS

ROOF WINDOWS AND SKYLIGHTS

The modern skylight has its roots in the clerestory windows of early Christian basilicas and Gothic Cathedrals. In an age when daylight was relied upon to provide most of the light in a space, builders and architects needed some way to bring the suns' rays deep into the inside of these large structures. Windows in the perimeter walls simply could not deliver enough light into the middle of the building. By raising the center section of the roof above the rest, they could locate a band of windows whose light could penetrate the dark interior.

As long as glass was expensive and hard to obtain, many window openings were unglazed, or covered with oiled paper or shutters, restricting the openings to walls. Around the mid-nineteenth century, glass began to be manufactured in the United States, increasing availability and reducing cost. This meant that instead of having to raise the roof for clerestories, light could be introduced into a space by placing a glazed opening in the roof—the skylight.

While most residential needs for natural light could be met with conventional windows, commercial and industrial spaces presented a problem. Typical commercial buildings consisted of long, narrow brick buildings which shared common sidewalls. This meant that only the relatively short expanses of end walls were available to be glazed. Interior rooms were left in the dark. This problem was typically solved by placing a large skylight over a centrally located main stairwell. Interior rooms surrounding the stairs were given windows onto the stairwell. The skylight provided light for the stairs and the surrounding rooms.

As electric light became the rule, the need to bring daylight into a building declined. The trend away from natural light continued until the energy crisis of the seventies. Now, with concern over a dwindling supply of natural resources, more designers are turning to daylight as a way to reduce the amount of electricity used for lighting.

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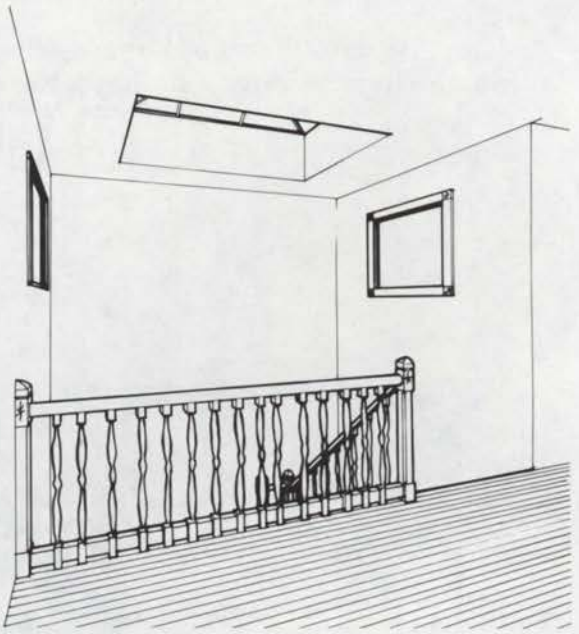


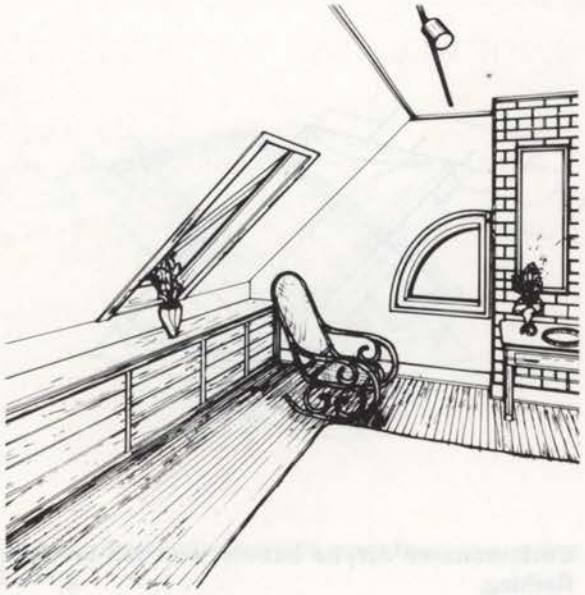
A skylight over a stairwell can provide light for the stairwell and surrounding rooms.

Skylights are an easy way to increase the perceived size of a space. Adding light and a view to a formerly dark corner will make the space seem bigger than it is, while allowing the space to be more fully used. A small, dark bathroom is an excellent candidate for remodeling with a skylight. The light from the skylight and the humidity from the bath or shower will allow plants to thrive, making the bathroom lush and bright.

Well-placed skylights can effectively highlight areas of a room or define one space from another. A skylight located over a stairway can add drama and interest while lighting the stairway so that it can be used safely without electric lights. In the kitchen, skylights can light the work area more uniformly than a conventional window.

Operable skylights and roof windows combine the advantages of a skylight and an operable window. While effectively lighting a space just as a fixed skylight would, they also provide ventilation. In the bathroom and kitchen, roof windows or venting skylights can remove excess moisture that is the result of cooking and bathing. This helps reduce the likelihood of moisture damage and mold.

Located in an upstairs hallway, roof windows can reduce the need for mechanical cooling. Through the natural convective currents, hot air rises to the highest point in the house. If ventilation is provided at this point, the hot air can escape. As the hot air escapes, fresh air is drawn in at lower levels. The removal of hot air, introduction of fresh outside air, and increased air movement combine to provide a real reduction in indoor temperature and humidity, as well as greater perceived comfort.



An unused attic space can be converted into bright, airy living space through the use of roof windows (if the floor joists are adequate to carry the load).

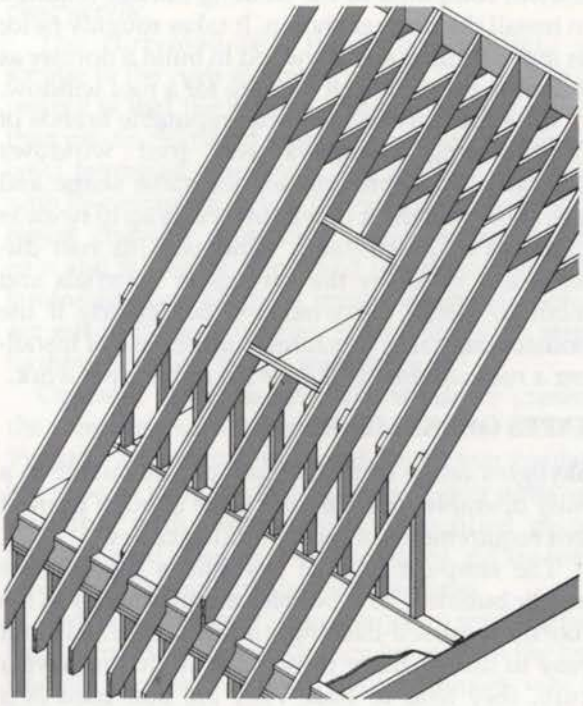
ATTIC CONVERSION

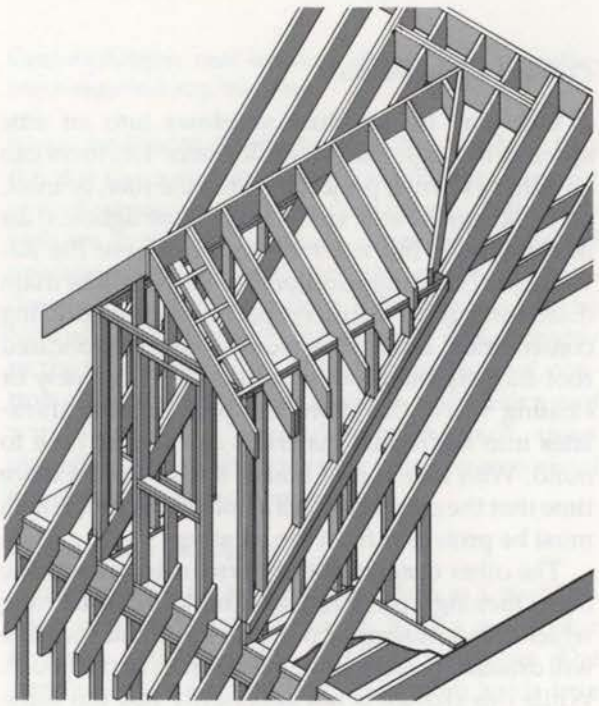
For the homeowner, roof windows are particularly useful in converting attic spaces into habitable rooms. Many homes, especially older ones, have roofs which are steep enough to provide ample headroom. The problem with these attic spaces is that they are dark. If there are any windows at all, they are usually small and located in the gable ends. If the house has a hip roof, there are probably no windows. This lack of natural light can make even a very large attic seem small and cramped.

Comparison of Materials Required

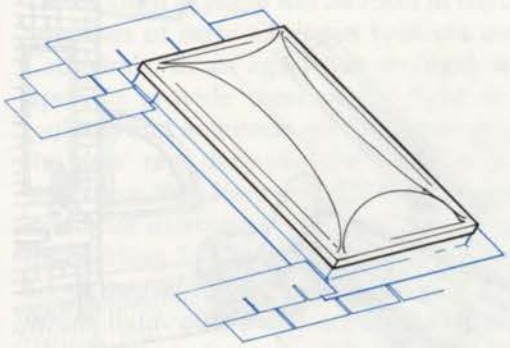
Material required	Skylight (as shown) (31 3/4 x 39 1/2")	Dormer (as shown)
2x6 (b.f.)	72.73	155.4
2x4 (b.f.)	0	73.5
sheathing (4x8' sheets)	6	13
roofing felt (squares)	1.76	1.44
shingles (squares)	1.76	1.44

* Amounts based on drawings shown for an area of roof 8 feet wide extending from eaves to ridge

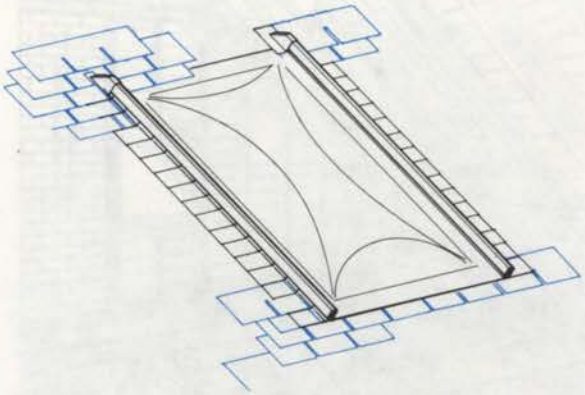




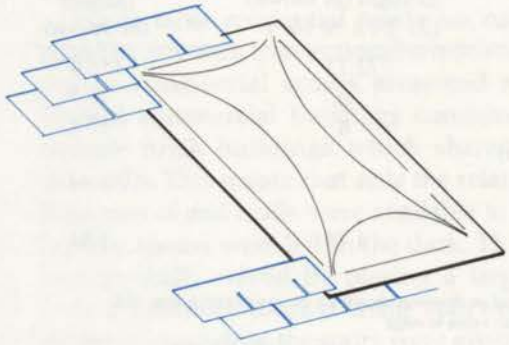
Framing required for a roof window and a dormer having a window of equivalent size.



Curb-mounted acrylic bubble with job-fabricated flashing.



Curbless acrylic bubble with standing side seams and step flashing.



Curbless acrylic bubble

One way to introduce windows into an attic space is through the use of dormers. Dormers can be either external, projecting from the roof, or inset, set back into the attic space. Both allow light and air into the attic, but external dormers have the advantage of creating additional headroom. The main disadvantage to dormers, particularly in existing construction, is that they require more complicated roof framing than roof windows. In either new or existing work, this more complex framing translates into additional materials and longer time to build. With an existing house, it also means more time that the contractor has a hole in the roof which must be protected from the weather.

The other concern about dormers is an aesthetic one. Opening up the roof and building something which either indents or protrudes from the roof line will drastically change the appearance of the house. While this change is not necessarily bad (on some houses, the addition of well-placed dormer windows may add to the character), the finished appearance of the house must be considered.

Skylights and roof windows can provide about a third more daylight and ventilation benefits as dormers, but without some of the concerns. As the illustration shows, the rough framing of a roof window is relatively simple. In fact, it is simple enough that a home owner with some hands-on experience and a few tools could install his or her own skylight.

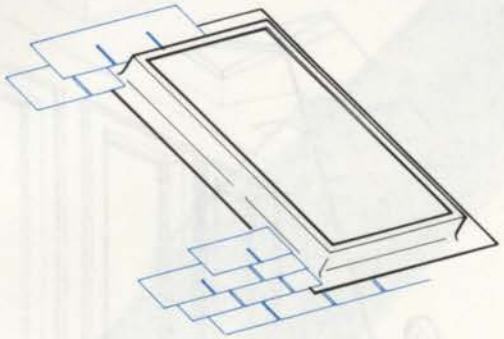
In addition to the framing being much simpler, roof windows also require less material to install than dormers. The chart (previous page) shows the amount of framing lumber, in board feet, required to do the rough framing to install a skylight as shown, compared to the framing lumber required to install the dormer shown. It takes roughly twice as much lumber and plywood to build a dormer as it does to do the rough framing for a roof window.

Cost comparisons between reputable brands of double-hung windows and roof windows (operable) of approximately the same shape and size show that the roof window costs up to twice as much as a double-hung window. This cost difference is offset by the savings in materials and labor to install the windows, particularly if the homeowner takes advantage of the ease of installing a roof window and does his or her own work.

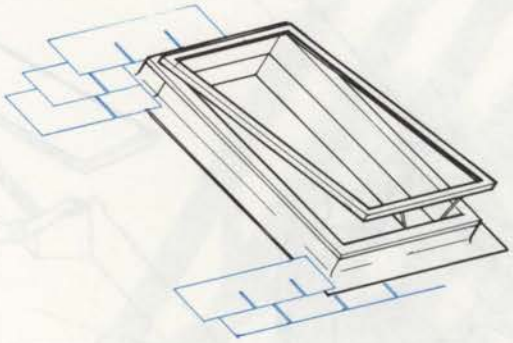
TYPES OF SKYLIGHTS

Skylights range from a simple plastic bubble to a fully operable roof window large enough to meet exit requirements of most building codes.

The simplest type of skylight is the curbless acrylic bubble. These bubbles mount directly to the roof deck, are self-flashing, and are inexpensive and easy to install. Since these bubbles do not have a curb, they tend to leak. They are best used in a garage or covered patio where there is no ceiling



Self-flashing fixed-glass skylight.



Top-hinged roof window with manufacturer-supplied flashing.

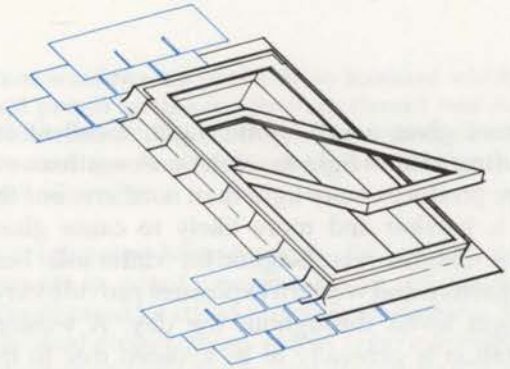
finish to be damaged, there will be less damage to contents below, and leaks will be detected before major damage to the roof framing and sheathing occurs. Another drawback to the simple acrylic bubbles is that they typically have only one layer of acrylic, so they are not as energy efficient as a double-layer skylight, and condensation is more likely to occur if they are installed over a heated space.

Better suited for use in a living space is the curb-mounted bubble. The raised curb, when properly flashed, is less likely to leak. Curb-mounted bubbles usually have double-layer glazing to provide an insulating air space, which reduces heat loss and condensation. Bubbles are available in tinted or clear acrylic.

The curb-mounted, fixed-glass skylight is similar to the curb-mounted bubble. The main difference is that the glazing material is glass rather than plastic. Standard units are supplied with insulated tempered clear glass, but are also available with low-emissivity glass for extra insulation, with tinted glass for protection against summer heat gain and fading of carpet and furniture, and with laminated glass for extra impact-resistance. Some are self-flashing, but better units come with step-flashing supplied by the manufacturer.

Operable skylights and roof windows present the consumer with the greatest number of choices. Virtually all are curb-mounted, with clear insulating glass as their standard glazing. Better units are available with low-emissivity gas-filled glass, bronze-tinted glass, or laminated glass. All are supplied with flashing by the manufacturer.

Roof windows operate in one of two ways. Either they pivot at the center, or they hinge from the top like an awning window. Roof windows which operate like awning windows operate by turning a

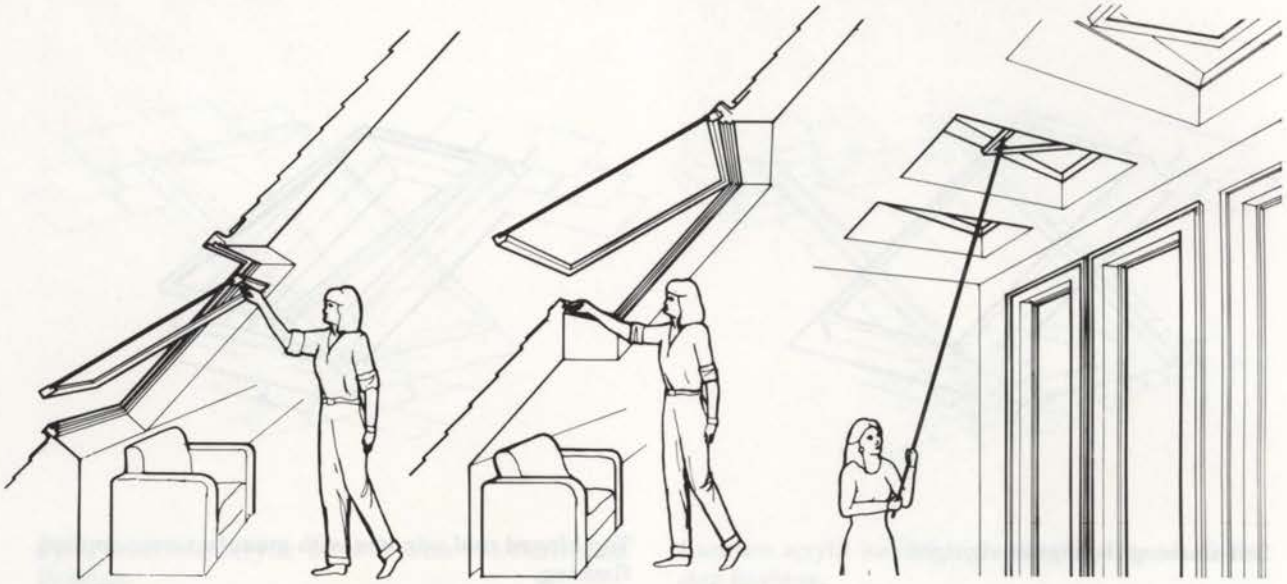


Center-pivoting roof window, shown with manufacturer-supplied step flashing.

hand crank located at the bottom. Among those that pivot at the center, at least one major manufacturer of roof windows offers a model on which the controls are on the top. The most convenient method of operation depends on the location of the roof window with respect to the floor. If the window is to be located low in the roof, top controls will probably be the most convenient. Higher up on the roof, controls at the bottom will be easier to reach. For a roof window located beyond normal reach, most manufacturers offer extension poles or motorized operation for added convenience.

Climate and Skylights

Just as unwanted heat gain and loss is a problem with conventional windows, it is a particular problem with skylights and roof windows. The standard rules for window orientation holds true for skylights and roof windows as well. Northern



The operating mechanism can be placed at the top of low roof windows or at the bottom of high windows for convenience in operation. Extension handles or electric operators are necessary for windows located in cathedral ceilings or lofts.

exposure gives a soft, gentle light, excellent for providing natural light to work by. A southern exposure produces more light than northern, but the light is harsher and more likely to cause glare. Southern exposure is also good for winter solar heat gain. Eastern and western exposures provide varying light levels throughout the day. A western orientation is generally to be avoided due to the harshness of western sunlight, particularly on summer afternoons, when the heat gain can be intolerable.

Low-Emissivity Glass

To keep heat in in the winter and block excess sun in the summer, manufacturers of skylights offer a variety of accessories and options. While the double-insulated glass (standard on better skylights) gives a 50% reduction in winter heat loss over single-glazing, double-insulated glass by itself is not enough to offset unwanted summer heat gain. Low-emissivity glass offered by some manufacturers can provide about a 50% reduction in winter heat loss and 20% reduction in summer heat gain over conventional double-insulated windows. If the space between panes is filled with an inert gas, such as argon, the savings can be even greater. (See *F11.2, Insulating Windows and Screens* for more information on wave-length-selective glass.)

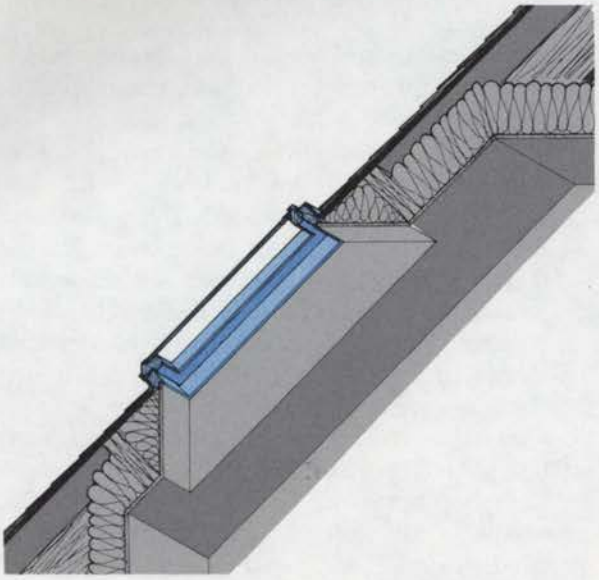
Shading Devices

When designing a house with conventional windows, charts and recommendations are readily available to help design proper roof overhangs or awning projections to shade out unwanted summer sun while admitting desirable winter sun. Thes e shading devices are not applicable to skylights and roof windows. However, many manufacturers offer externally mounted awnings and/or internally mounted blinds and shades to provide sun control. On operable roof windows, these shading devices typically attach to the sash so that the sash can be opened with the shading device in place. This allows for maximum shading and ventilation at the same time.

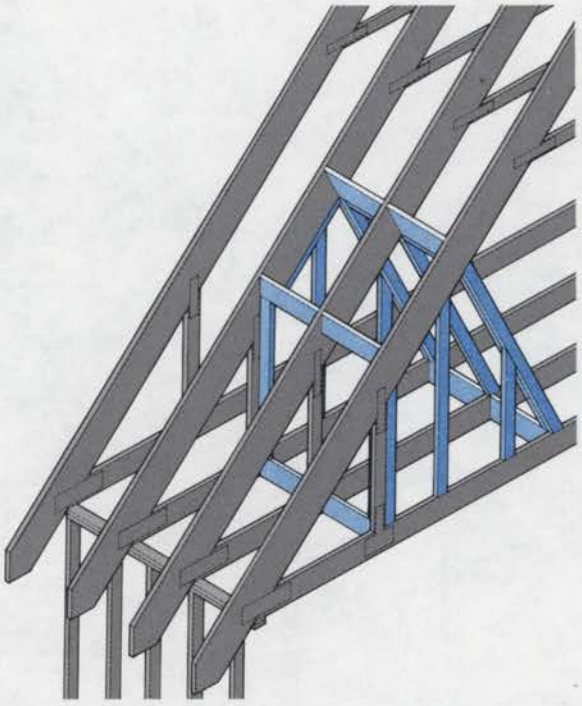
Exterior awnings can be opaque or semi-transparent. Both types are usually a plastic or fiberglass woven mesh. The opaque awnings have a tightly woven mesh which blocks the view while providing shade. The loosely-woven semi-transparent type allows viewing and provides shade at the same time.

Interior shading devices consist of roll-up blinds and venetian blinds. Roll-up blinds operate much like window shades, except that they are held against the window at the bottom. They are usualiy available in neutral colored fabric on the interior, and some manufacturers offer an aluminum reflective coating on the exterior. If held securely against the frame for their entire length, they can help reduce winter heat loss by creating an insulating air space between the fabric and glass.

The advantage of venetian blinds over roll-up shades is that they can be adjusted to allow in as much light as desired and to provide shading and



Typical roof window installation in a sloped ceiling. The splayed opening spreads the light over a larger area of the room.



Roof windows are available in standard widths that will permit installation between trussed roof framing without modifying the trusses. The existing framing is shown in gray, and the framing to be added for the light well is in color.

view at the same time. Some types may also help reduce winter heat loss.

For skylights in hard-to-reach places, some manufacturers offer remote operating devices. These devices can be as simple as a pull cord or a telescoping rod with a hook. Some models are available with electric remote control operators.

Flashing

The simplest skylight to install is a one-piece, curbless, self-flashing unit. This is also the least effective at stopping water from leaking around the opening, especially on low-slope roofs. Some building codes contain restrictions on the use of curbless skylights. They should be avoided except for covered patios and areas where leakage is not harmful.

Both fixed and operable skylights are available as self-flashing, curb-mounted units. The flashing can be either plastic or metal, depending on the construction of the skylight. Curb mounting provides better protection against leaks than curbless, and the self-flashing feature makes them easier to install. For roofs with a slope of 4 in 12 or greater, this method of flashing may be adequate, but most manufacturers recommend that a special sloping curb be used with flatter roofs. Self-flashing skylights also do not work well with thick roofing materials such as slate, clay tile, wood shingles or some profiles of metal roof. In those cases, flashing flanges will not work, and a plain skylight with separate flashing, either supplied by the manufacturer or custom fabricated, should be used.

Curb-mounted units with step-flashing offer the best protection against leaks. The preformed head and sill flashing assemblies supplied by the manufacturer have carefully folded and welded corners to guard against leaks in what would be complicated locations for job-built flashing. The individual step-flashing pieces weave between the shingles and overlap to give more protection than a continuous flashing. Some manufacturers provide different flashing systems for various roof conditions, such as low slopes and thicker roofing materials.

CONDENSATION

Even the best skylights are subject to condensation if the proper conditions are present. Condensation is caused when moisture-laden air strikes a surface which is colder than the dew point of the air. The air can no longer hold the moisture in vapor form, so the moisture condenses into liquid water, or frost if the surface is below freezing. (For more on condensation, see circular F6.2, *Moisture Condensation*) For windows having double glass with a 1/2-inch air space, 0°F. outside air temperature and 70°F. indoor air temperature, condensation occurs at an indoor relative humidity of 40%. As houses are being made more air-tight, it is not uncommon to find indoor relative humidity levels greater than 40%. While indoor humidity can and should be regulated through control of moisture sources and mechanical ventilation, window manufacturers

A roof window or skylight can provide additional light and ventilation to a room on the first floor of a 1 1/2-story house by using a light well through the area behind the knee wall on the second floor.

recognize that conditions which support condensation occur frequently. In order to prevent condensation which forms on skylights from streaking and damaging wall and ceiling finishes, and "raining" into the room, good quality skylights now come with condensation gutters unobtrusively located at the sill.

Installation

In a room with a cathedral ceiling, skylight installation is a relatively simple matter. All that is required is to cut a rough opening in the roof, install additional rafters and headers as necessary, and install the skylight according to the manufacturers instructions.

Rooms with a flat ceiling and an attic above require more planning and work. In these situations, a light well must be constructed. The walls of the light well may be vertical, or they may be splayed so that the opening in the ceiling is considerably larger than the skylight itself. If the skylight is to be used primarily as a source of natural light, a splayed opening is preferred because the light is distributed over a wider area of the room.

The walls of the light well may be finished in any material that is compatible with the room. Generally, these walls are insulated wood stud walls, covered with drywall and painted. They may be paneled, mirrored, wallpapered, etc. The light well walls will be subjected to intense sunlight, and whatever material is used should be capable of withstanding this sun without excessive deterioration or fading. Fabrics may not be suitable as they rot in intense sunlight, and bright paint colors or wallpaper patterns may fade. In general, light-colored surfaces are preferred as they reflect light into the room below, making the room brighter.

When installing a skylight which requires a light well, careful thought should be given to its placement. The light well will pierce the attic, and ductwork, electrical wiring, etc., will either have to be avoided or moved. One manufacturer has solved this problem by using a flexible light shaft, available as an accessory to the skylight. This shaft is constructed of a fiberglass mesh with a light-reflective vapor barrier covering on the inside and a reflective coating on the outside. The shaft is flexible, and can be formed to the desired configuration like a bellows. This allows the shaft to be routed around ductwork and conduit. Minimal framing is required for the shaft. No finish is required on the inside of the shaft, but the attic side should be insulated.

For additional information on windows and their use, Circular F11.0, *Window Planning Principles*, Circular F11.1, *Selecting Windows*, Circular F11.2, *Insulating Windows and Screens*, and Circular F11.3, *Replacement Windows* are available for 50 cents each plus shipping and handling. Technical Note 16, *Speaking of Windows* is a 32-page collection of information on windows, with an illustrated glossary defining windows and their parts. It also includes a history of glass and diagrams of window parts and installation. It is available for $3.00 plus shipping and handling. A complete list of Council publications is available upon request.